

REMARKS

Upon entry of the Amendment, Claims 1-13 and 15-214 will be pending in the application.

Claim 1 is amended to recite “first silicon-diffused metal layer including no carbon therein”. Claim 12 is amended to recite “said first silicon-diffused metal layer includes no metal silicide formed thereon.” Claim 51 is amended to recite “a silicon-diffused copper layer including no copper silicide formed thereon and including no carbon therein”.

Claim 14 is canceled.

Claims 18-50 and 52-212 have been withdrawn from consideration by the Examiner.

New Claims 213 and 214 are added. Claim 213 is based on support, for example, at page 19, lines 15-18, and Claim 214 is based on support, for example, at page 17, lines 13-15, of the specification as originally filed. No new matter is added.

Entry of the Amendment along with reconsideration and review of the claims on the merits are respectfully requested.

Formal Matters

Applicants appreciate that the Examiner has acknowledged the claim(s) for foreign priority and the receipt of some of the priority documents. More particularly, the Examiner acknowledged the claims for foreign priority based on an application filed in Japan on “10/17/03” [*sic* - apparently 10/17/2002] and 5/5/03.

AMENDMENTS TO THE DRAWINGS

Please replace the drawing sheets numbered 2/87 and 21/87 with the concurrently attached replacement sheets. The annotated sheets indicate that Figs. 1D and 5D of the prior art are amended to each include a swirling arrow, which indicates that the etching stopper 102 is etched back by a dry etching process, followed by a wet stripping process performed upon the insulating interlayer 103 and the insulating interlayer 101, so that residues of the dry etching process are completely removed (see page 8, lines 7-11).

Attachment: Annotated Sheets
Replacement Sheets

However, the Examiner states that Applicants have not filed certified copies of these foreign applications as required by 35 U.S.C. §119(b).

In response, Applicants point out that the foreign priority document filed on October 17, 2002, was filed in the parent application Ser. No. 10/281,321, now abandoned. And the foreign priority document filed on May 5, 2003, was filed in the present application on August 28, 2003. Applicants also point out that a third foreign priority document based on a Japanese application filed on May 8, 2002, should be acknowledged since priority was claimed, and it was filed, in the parent application Ser. No. 10/281,321, now abandoned.

Thus, Applicants respectfully request that the Examiner check the records again for receipt of all three foreign priority documents.

Submission of Substitute Declaration

Applicants note that in reviewing the file, the Declaration and Power of Attorney, signed and dated by the inventors on August 18, 2003, included a typographical error. The filing date for Japanese Application Number 2003-130484 was listed as "May 05, 2003". However, the Japan Patent Office's certification lists the proper filing date as May 8, 2003.

Thus, Applicants submit a substitute Declaration, filed concurrently herein, and request replacement of the previous Declaration with the presently filed one.

AMENDMENT UNDER 37 C.F.R. § 1.111

U.S. Application No. 10/650,193

Q77191

Objections

A. The Examiner asserts that the title of the invention is not descriptive, and states that a new title is required that is clearly indicative of the invention to which the claims are directed.

In response, Applicants respectfully traverse the Examiner's objection and submit that the title as written is fully in compliance with MPEP §606.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the Examiner's objection to the title.

B. The Examiner objects to the disclosure because Applicants' CIP related application information should be updated, and requires appropriate correction.

Applicants amend the first sentence of the specification to recite "This is a Continuation-In-Part of Application No. 10/281,321 filed October 28, 2002, now abandoned; the disclosure of which is incorporated herein by reference."

Accordingly, Applicants respectfully request reconsideration and withdrawal of the objection to the disclosure.

Claim Rejections - 35 U.S.C. § 112

Claims 3 to 7, 12 and 51 are rejected under 35 U.S.C. § 112, second paragraph, as assertedly being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

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A. The Examiner asserts that in claim 3 it is unclear and confusing to what is meant and what shows "said low-k material layer comprises one of a ladder-type hydrogen siloxane layer and a porous ladder-type hydrogen siloxane layer." The Examiner asks, for the elected species, where is this low-k material layers discussed in the specification?

In response, Applicants kindly point the Examiner to disclosure in the specification, for example, at pages 44-46 (in particular, page 44, lines 1-4 and page 46, lines 10-13), which support the subject matter of claim 3. At an earlier point, the specification states that "the insulating interlayer 110 can be made of a low-k material having a lower dielectric constant than that of silicon dioxide." (page 19, lines 5-8).

B. The Examiner also asserts that in claims 12 and 51 it is unclear and confusing to what is meant by "wherein said first silicon-diffused metal layer includes no metal silicide." The Examiner asks how is there no metal silicide in a layer that comprises silicon and a metal, and how does this relate to the elected species?

Applicants kindly point the Examiner to disclosure in the specification, for example, at pages 16-26 (in particular, Fig. 8A and page 19, line 31 to page 20, line 9), which discuss the absence of metal silicide (specifically Cu silicide) formed on the silicon-diffused metal layer and the benefits thereof.

Furthermore, Applicants amend Claims 12 and 51 for clarification. No metal silicide is formed, or present, on the silicon-diffused metal layer.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejections under 35 U.S.C. § 112, second paragraph.

Claim Rejection - 35 U.S.C. § 102

Claims 1-10 and 12-15 are rejected under 35 U.S.C. § 102(e) as assertedly being anticipated by Chambers et al. (U.S. Patent Application Publication # 2003/0137050 A1), for the reasons of record.

The Examiner cites Chambers (Figures 1 to 8) as disclosing a semiconductor device comprising an insulating underlayer; a first insulating interlayer formed on said insulating underlayer, said first insulating interlayer having a groove; a first silicon-diffused metal layer buried in said groove; and a first metal diffusion barrier layer (element 110) formed on said first silicon-diffused metal layer and said first insulating interlayer.

Applicants respond as follows.

Claim 1 is amended to recite a negative limitation that no carbon is included in the first silicon-diffused metal layer.

Chambers et al does not anticipate each and every element of the present invention.

In Claim 1, the material such as Cu_xSi_y of the silicon-diffused metal layer includes no carbon; the material of the present invention is quite different from $\text{Cu}_x\text{C}_y\text{Si}_z$ of the carbon-doped and silicon-doped copper interconnect of Chambers et al.

Also, in Chambers et al., hydrogen is used not to clean the surface of the carbon-doped copper (see lines 12-14 of [0048]). On the other hand, hydrogen of Claim 13 of the present invention has nothing to do with such a cleaning process.

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Furthermore, Chambers does not disclose at least the element of the present invention requiring “a first metal diffusion barrier layer formed on said first silicon-diffused metal layer and said first insulating interlayer.” Although the Examiner cites to Chambers’ barrier layer (see element 110 in Fig. 1), Applicants kindly point out that Chambers’ barrier layer is not “formed on said first silicon-diffused metal layer and said first insulating interlayer”. Thus, Chambers’ barrier layer cannot anticipate the specifically claimed metal diffusion barrier layer of the present invention. Furthermore, although Chambers discloses a passivation layer or inter-level dielectric layer (see element 130 in Fig. 1) to protect the interconnect from contamination like moisture and/or to provide insulation between layers of interconnects (see Chambers, page 2, last 5 lines of [0017]). Chambers discloses a passivation layer such as a Si_3N_4 layer (see element 5120 in Fig. 5; and page 4, [0037]); this passivation layer is not a metal diffusion barrier layer according to the present invention.

In Chambers et al., it is true that silicon is diffused into the interconnect; however, it is not expressly indicated that silicon is diffused into the entirety of the interconnect. Therefore, new claim 213 is not obvious from Chambers et al.

Thus, Chambers fails to anticipate or render obvious each and every element of the present invention.

Accordingly, for at least the foregoing reasons, Applicants respectfully request reconsideration and withdrawal of the rejection under 35 U.S.C. § 102(e).

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Claim Rejection - 35 U.S.C. § 103

Claims 11, 16, 17 and 51 are rejected under 35 U.S.C. § 103(a) as assertedly being unpatentable over Chambers et al. (U.S. Patent Application Publication # 2003/0137050 A1), for the reasons of record.

The Examiner initially notes that the 35 U.S.C. § 103 rejection based on Chambers' asserted disclosures of a silicon diffused copper layer and a SiC etching stopper layer; and W diffusion layer and the silicon diffused copper layer deals with an issue (i.e., the integration of multiple pieces into one piece or conversely, using multiple pieces in replacing a single piece) that has been previously decided by the courts as discussed in the Office Action.

Applicants respond as follows.

Claim 51 is amended to recite "a silicon-diffusing copper layer including no copper silicide formed thereon and including no carbon therein".

Chambers et al. does not anticipate or render obvious each and every element of dependent Claims 11, 16, and 17, and independent Claim 51, for at least the same reasons as given above for the patentability of independent Claim 1.

Similarly, Chambers et al. does not anticipate or render obvious each and every element of independent Claim 51. For example, Chambers does not disclose at least the element of Claim 51 requiring "a copper diffusion barrier layer made of at least one of SiCN, SiC, SiOC and organic material and formed on said silicon-diffused copper layer and said insulating interlayer." Although the Examiner appears to again cite to Chambers' barrier layer (see element 110 in Fig. 1), Applicants kindly point out that Chambers' barrier layer is not "formed on said silicon-

diffused copper layer and said insulating interlayer". Thus, Chambers' barrier layer does not render obvious the specifically claimed copper diffusion barrier layer of the present invention. Furthermore, although Chambers discloses a passivation layer or inter-level dielectric layer (see element 130 in Fig. 1) to protect the interconnect from contamination like moisture and/or to provide insulation between layers of interconnects (see Chambers, page 2, last 5 lines of [0017]). Chambers discloses a passivation layer such as a Si_3N_4 layer (see element 5120 in Fig. 5; and page 4, [0037]); this passivation layer is not a metal diffusion barrier layer according to the present invention.

Based on at least the foregoing reasons, it would also NOT have been obvious to one of ordinary skill in the art to use Chamber's asserted disclosure of the SiC etching stopper and the silicon-diffused copper layer and the W diffusion layer and the silicon diffused copper layer as "merely a matter of obvious engineering choice". Thus, Chambers fails to anticipate or render obvious each and every element of the present invention.

Accordingly, for at least the foregoing reasons, Applicants respectfully request reconsideration and withdrawal of the rejection under 35 U.S.C. § 103(a).

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

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The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

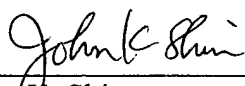
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23373

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Date: March 2, 2005

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Appl. No. 10/650,193
Docket No. Q77191
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Reply to Office action of Nov. 3, 2004
Annotated Sheet

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Fig. 1C PRIOR ART

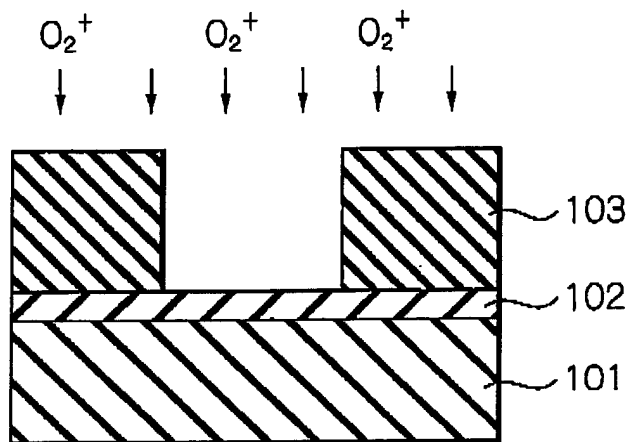
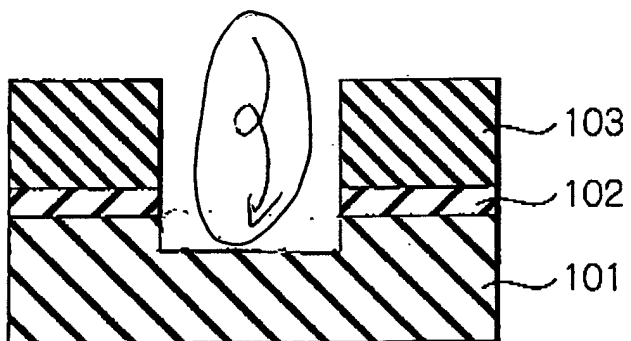


Fig. 1D PRIOR ART



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Fig. 5C

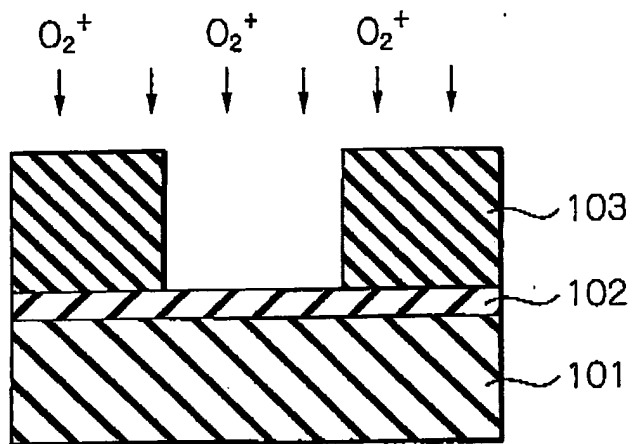


Fig. 5D

